

From **REDCOR's** Original Modular
Systems Component Concept, evolves the
663 series* **"TOTAL SYSTEM IN A BOX."**

Includes 256 channels of Multiplexer,
A-D Converter, Sample and Hold.

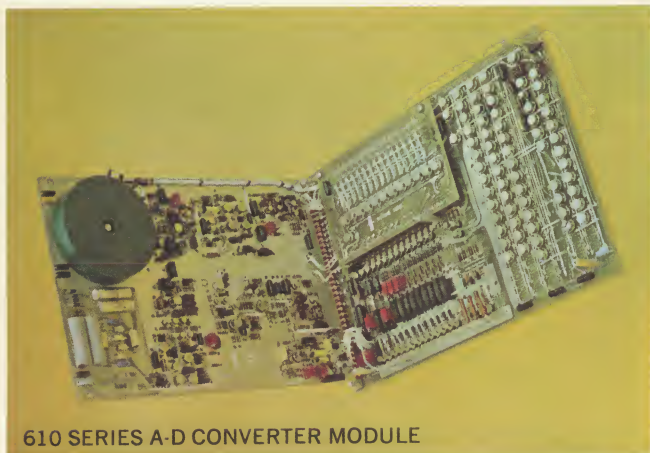
PLUS Additional Power and Space to
provide the "Total System" concept

ALL in ONE 8^{3/4}" chassis

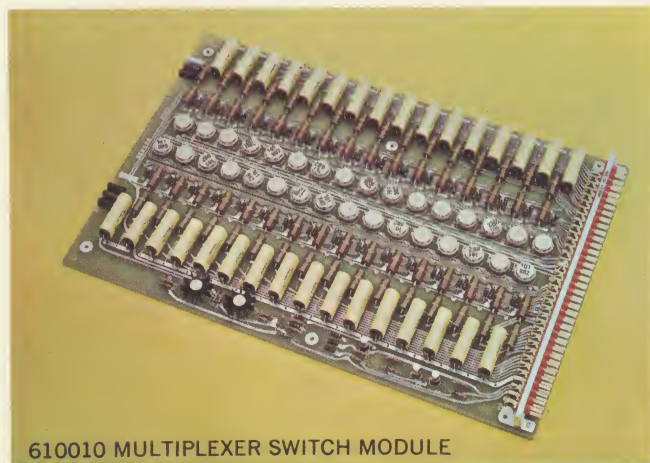
*Digital Monolithic and Linear Hybrid Integrated Circuit All Silicon Construction.



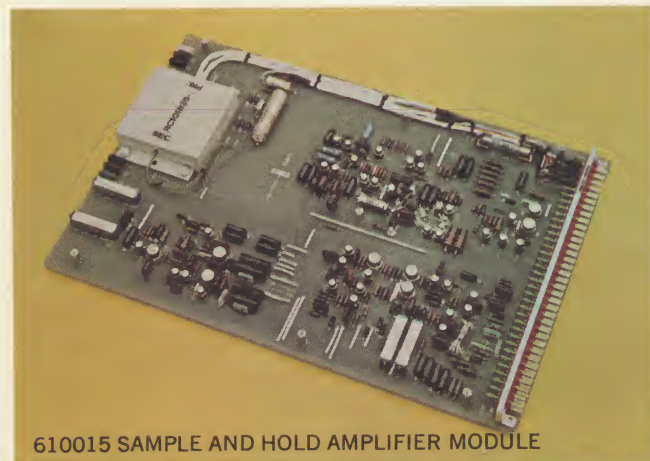
REDCOR 663 Series Data System



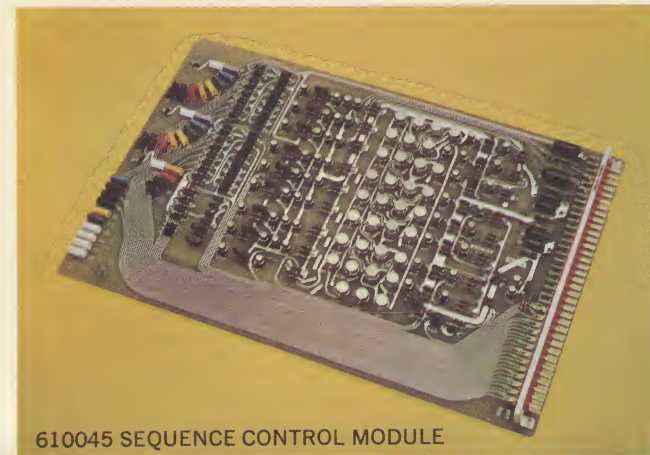
610 SERIES A-D CONVERTER MODULE



610010 MULTIPLEXER SWITCH MODULE



610015 SAMPLE AND HOLD AMPLIFIER MODULE



610045 SEQUENCE CONTROL MODULE

FEATURES

- ☐ SYSTEM REPEATABILITY AND RESOLUTION — $\pm 0.01\%$ $\pm \frac{1}{2}$ L.S.B., 3 sigma error distribution (15 bit binary or 17 bit BCD).
- ☐ SYSTEM THROUGHPUT RATES — 43 kc at 13 bits and 36 kc at 15 bits.
- ☐ DIFFERENTIAL SAMPLE AND HOLD — Aperture time less than 100 nanosecs; 5 μ secs settling time. (0.01%)
- ☐ HIGH INPUT IMPEDANCE — 100 megohms for both differential and common mode signals (selected or unselected channels).
- ☐ ANALOG-DIGITAL GROUND ISOLATION is obtained by differential amplifiers with high common mode rejection maintaining a system accuracy of 0.01%.
- ☐ OVERLOAD RECOVERY — Each input is clamped so that the system will recover from a 100 V overload in one channel time.
- ☐ "NO COST" OPTIONS include true and false digital outputs, positive or negative logic levels from 6 V to 12 V, Absolute Value and Sign or complement output coding, internal-external bit clock, and internal-external reference.
- ☐ AUTOMATIC — sequential or random access multiplexer address, internal-external bit clock. MANUAL by front panel multiplexer advance and A-D start.
- ☐ EXTRA CARD SLOTS for expansion of the basic system using compatible REDCOR modules to meet specific customer total data acquisition systems requirements.
- ☐ MULTIPLEXER EXPANDABLE from 1 to 256 channels in 1 channel increments (1 plug-in microelement per channel).
- ☐ INTEGRATED CIRCUIT DESIGN AND ALL SILICON DESIGN increases system reliability and overall performance; reduces physical size; lowers system power consumption.
- ☐ MTBF — Calculated per MIL handbook 217 — 3500 hours. Actual experience in excess of 36 machine months operation with no failures.
- ☐ TOTAL PLUG-IN FEATURES including power supply and front panel assembly provides unique ease of maintenance.
- ☐ PLUG-IN MICROELEMENTS allow inexpensive spares provisioning and minimizes total troubleshooting costs.
- ☐ BUILT-IN FILTER AND ATTENUATOR — No reduction in number of channels necessary.
- ☐ EXTERNAL REFERENCE — The A-D Converter can be slaved to an external reference voltage if desired.
- ☐ PATCHABLE number of sequence positions or channels.
- ☐ TEST POINTS on the integrated circuit modules eliminates the necessity of back-plane probing.
- ☐ COMPLETE FUNCTIONS are contained on individual 8"x12" modules for ease of maintenance. The system consists of only 5 different types of modules including power supply.

For complete specifications, write for Brochure 663.

REDCOR

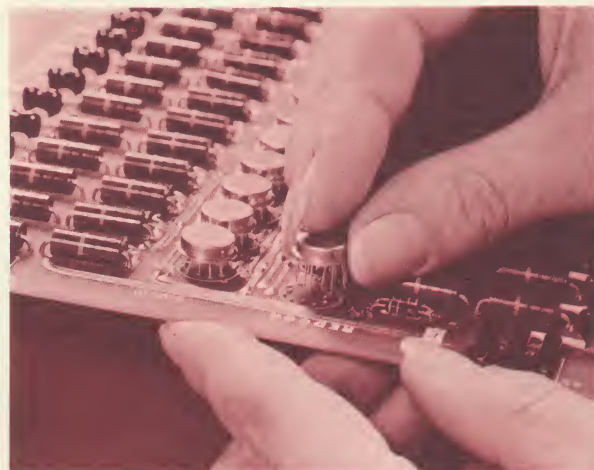
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Represented by:

REDCOR 663 SERIES DATA SYSTEM

REDCOR's new 663 Series Data System provides the design engineer with a building-block concept to cover a diverse range of data acquisition and conditioning applications. This "state of the art" system is a natural outgrowth of previous REDCOR high performance data systems using the "system in a box" concept. The basic 663 data system uses standard REDCOR modules consisting of a multiplexer switch, A-D converter, multiplexer sequence control, differential sample and hold amplifier, and power supply. Compatible building-block modules, such as, D-A converter, data distributor, buffer amplifier, simultaneous sample and hold, low-level differential preamplifier, and special custom logic modules, can be added in extra card slots to meet specific customer data acquisition requirements. All modules used in the 663 system are standard REDCOR products with integrated circuit microelements as the design criteria. These compatible standard product modules provide the flexibility required by highly specialized and variable data acquisition systems.

The capability of expanding in one channel increments is evidence of the high quality design of the 663 data system. When expanding the number of channels, simply plug-in a REDCOR multiplexer switch microelement.



MULTIPLEXER SWITCH PLUG-IN MICROELEMENT

SPECIFICATIONS

ANALOG INPUTS

(INCLUDING DIFFERENTIAL SAMPLE AND HOLD)

Channel Capacity 32 channels/module	256 channels with attenuators
Crosstalk	open switch leakage impedance is 100 meg- ohms at 1 kc/s/er channel
Input impedance 10 V input	100 megohms at DC (excluding input attenuators)
100 V input	(depends on attenuator and filter)
Noise referred to output	1 mv p-p
Source impedance	0 to 5 K ohms
Input voltage ±100 V ±10 V	with attenuators without attenuators
Maximum overvoltage ±125 V ±100 V	with attenuators without attenuators
Switching frequency	DC to 100 kcs
Settling time	5 μsecs to ±0.01 % interlaced operation
Overload recovery time	10 μsecs to 0.05 % of final value
Aperture time	less than 100 nsecs max.
Common mode input voltage	1 V p-p dc to 60 cps
Common mode source impedance	0-5 k
Common mode rejection	60 db dc to 60 cps
Common mode input impedance (256 channels)	100 megohms dc to 60 cps

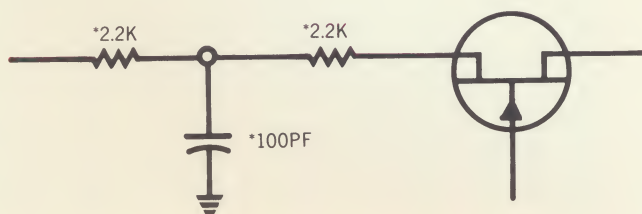


Figure 1. Analog Inputs

*Values are for minimum filtering

A-D CONVERTER ACCURACY

Quantizing error	± 1/2 least significant bit
Coding linearity	±0.01 %
Full scale stability	±0.01 %
Full scale temperature coeff / °C	±0.005 %
Zero stability 30 days	±0.01 %

SYSTEM THROUGHPUT RATES

13 bits	43 kc
15 bits	36 kc

SYSTEM ERROR ANALYSIS*

NOTE

Full scale input is 20 V p-p with a digital resolution of one part in 32,768. All errors are referenced to the input in peak-to-peak values.

	Predictable Errors (E _p)	Random Error (E _r)
Multiplexer		
Crosstalk	100 ppm	
Linearity error	20 ppm	
Noise		25 ppm
Drift (24 hours)		25 ppm
Total	120 ppm	50 ppm
Sample-and-hold		
Linearity	100 ppm	
Noise		50 ppm
Drift		50 ppm
Gain stability		50 ppm
Total	100 ppm	150 ppm
A-D Converter		
Linearity	30 ppm	
Noise		15 ppm
Drift		30 ppm
Gain stability		50 ppm
Quantizing error		30 ppm
Total	30 ppm	125 ppm

$$\begin{aligned}
 \text{System error} &= E_p \text{ Multiplexer} + E_p \text{ A-D Converter} + \\
 &\quad E_p \text{ Sample-and-Hold} + \\
 &\quad \sqrt{(E_r \text{ Multiplexer})^2 + (E_r \text{ A-D Converter})^2} \\
 &\quad + E_r (\text{Sample-and-Hold})^2 \\
 &= 250 + \sqrt{50625} \\
 &= 490 \text{ ppm p-p}
 \end{aligned}$$

$$\text{System error} = \pm 0.0245 \%$$

*Typical System Repeatability

DIGITAL INPUTS

Logic Level (input)	
Negative polarity option	Binary "1" — 6 V (min.) Binary "0" 0 V
Positive polarity option	Binary "0" +6 V (min.) Binary "1" 0 V
Trigger noise rejection	+1.5 V

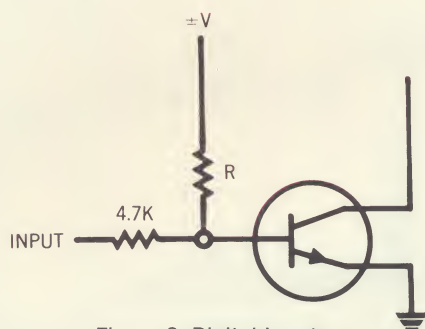


Figure 2. Digital Inputs

Positive polarity:	V is +3 V, R is 3 K ohms
Negative polarity:	V is — 12.5 V, R is 22 K ohms

Converter reset input

External clock

Convert input

Random access	1	2 ⁰
	2	2 ¹
	4	2 ²
	8	2 ³
	16	2 ⁴
	32	2 ⁵
	64	2 ⁶
Random access	128	2 ⁷

Random access strobe

Random access sequential select

Multiplex Reset input

DIGITAL OUTPUTS

Number of binary bits	11, 13, or 15
Number of BCD bits	9, 13, or 17
BCD coding	8421
Bit rate (maximum)	1.5 μ sec/bit
Parallel data outputs	(see figure 3)
Serial data outputs	(see figure 3)
Output levels	
Positive polarity option	Binary "0" (see table 1) Binary "1" 0 V
Negative polarity option	Binary "1" (see table 1) Binary "0" 0 V
Serial clock output	(see figure 3)
End-of-conversion output	(see figure 3)
Temperature	
Temperature range	0° to 50°C
Warm-up time	15 minutes at rated accuracy
Cooling	No cooling required except if system exceeds ambient of 50°C
Temperature coefficient	*0.1 namps/°C

* Effect would depend on source impedance

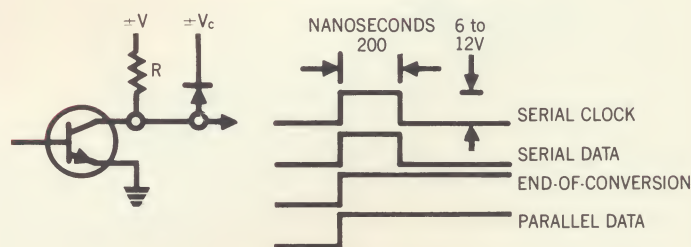


Figure 3. Digital Outputs

NOTE: Parallel data and end-of-conversion present until a reset or convert input.

Negative polarity: V is — 12.5 V, V_c is 6 to 12 V, Q is PNP, diode is reversed

Positive polarity: V is +12.5 V, V_c is 6 to 12 V, Q is NPN, diode is as shown

Serial clock and serial data outputs: R is 680 ohms

End-of-conversion and parallel outputs: R is 1.2 K ohms

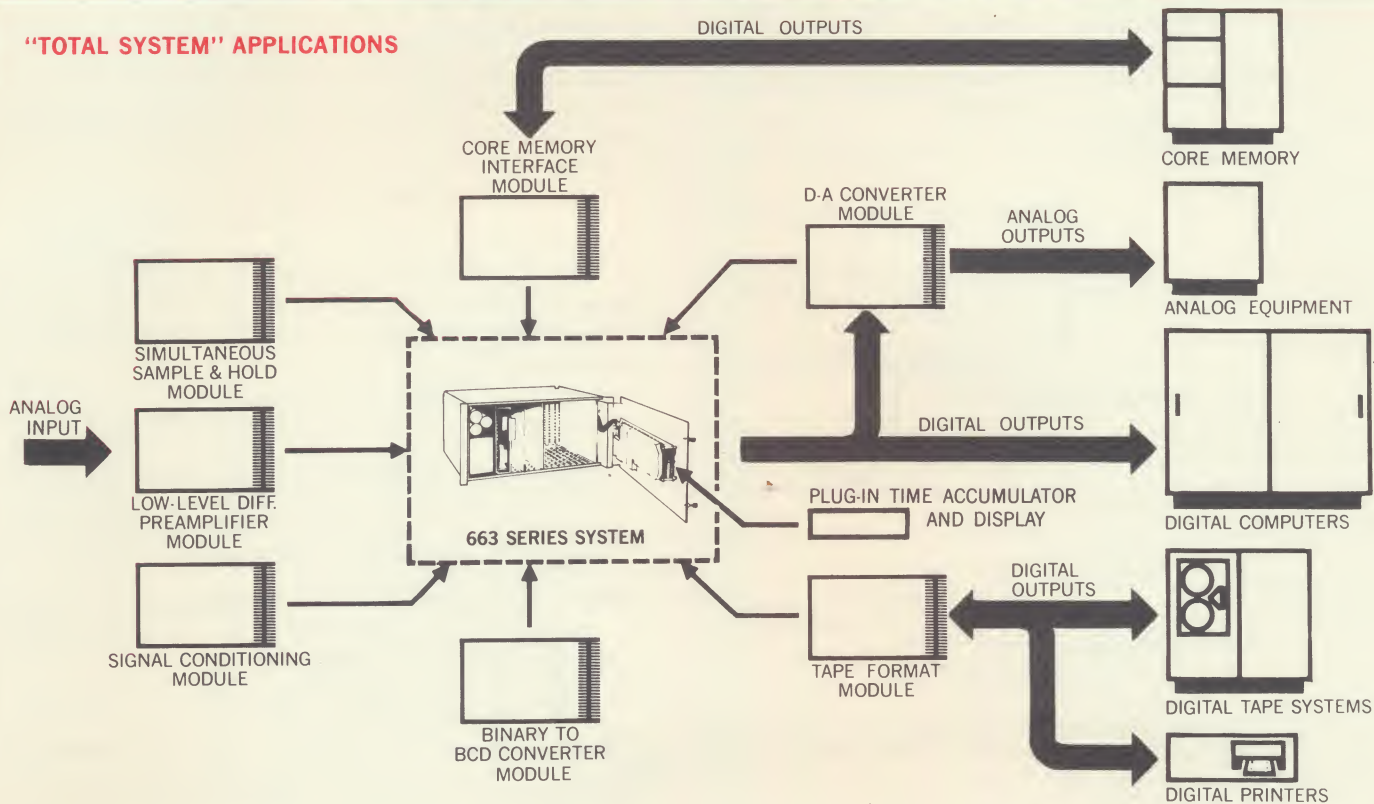
Mechanical

Analog inputs	Malco 50 pin Male Type 2710185-5
Digital inputs	Malco 50 pin Male Type 2710185-5
Display	Amperex Tubes
Size	
Width	19 inches
Height	8 3/4 inches
Depth	18 inches
Weight	45 lbs.
Power	115 or 230 vrms, 100 watts max., 50 to 400 cps

APPLICATION

Using REDCOR's "total system in a box" concept, standard REDCOR 610 series integrated circuit modules can be added to 663 system to meet customer data system requirements, such as, data acquisition, linkage, computer analog IO, process control, etc. This flexibility is enabled by the extra space and power in the 663 series data systems.

"TOTAL SYSTEM" APPLICATIONS



COMPUTER "LINKAGE" APPLICATIONS

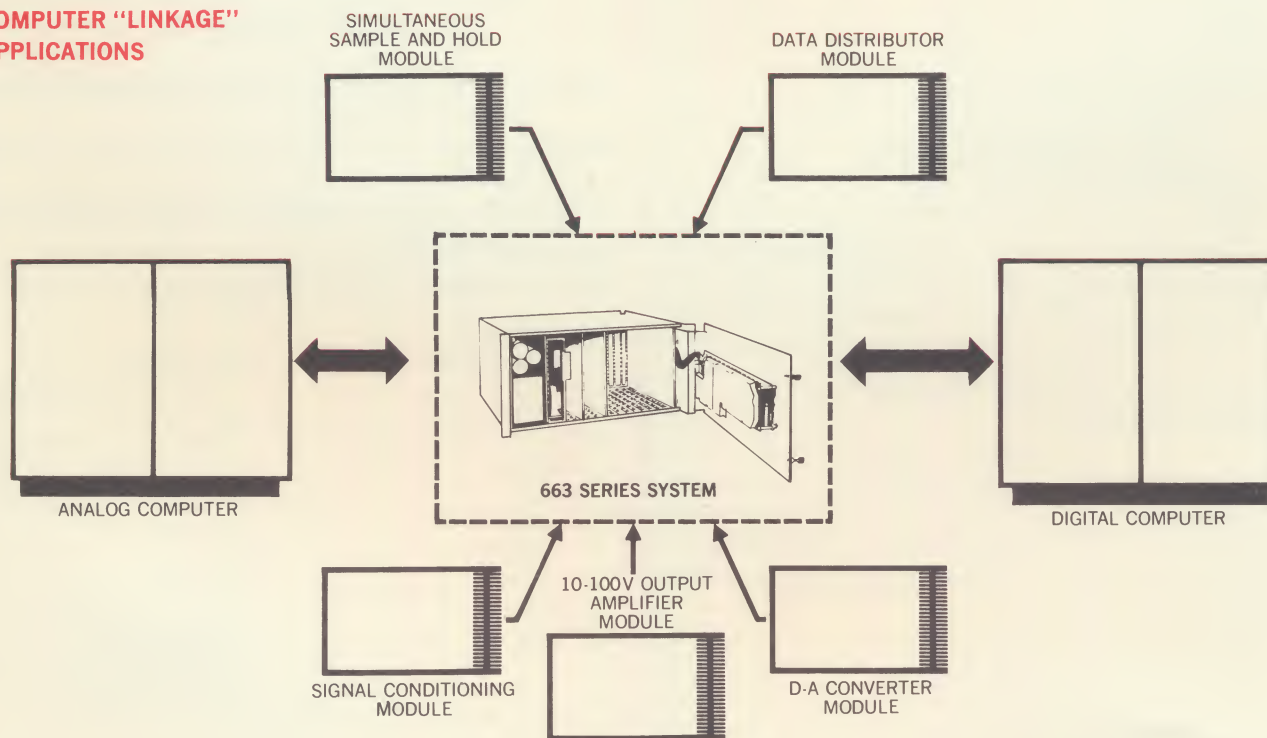
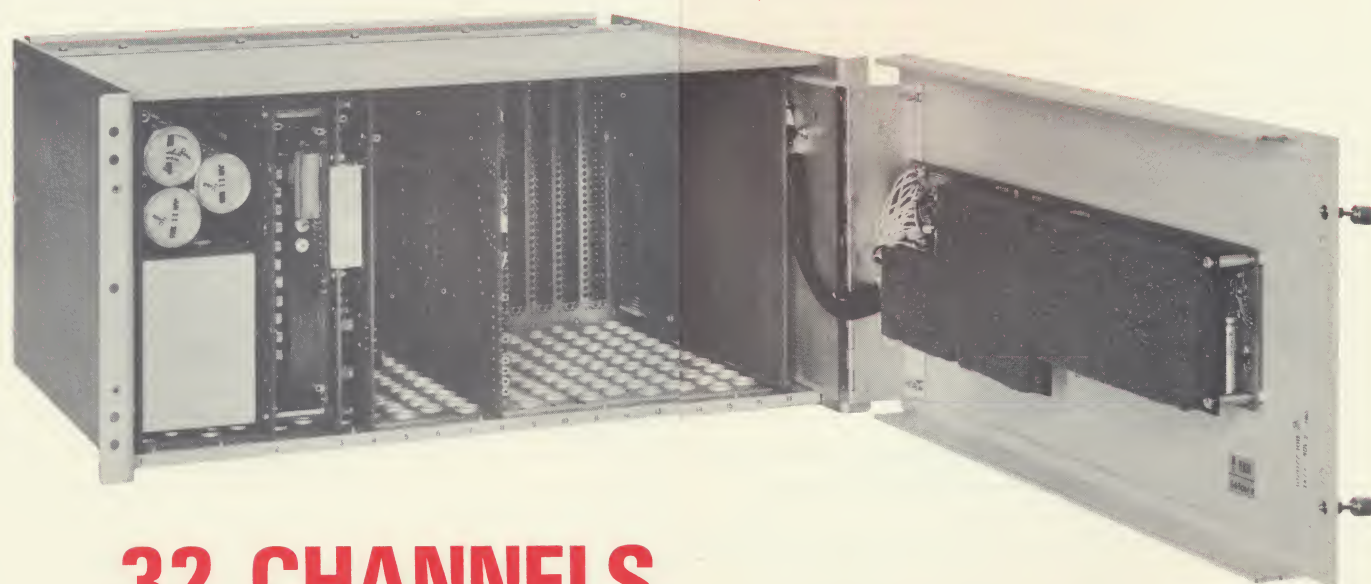
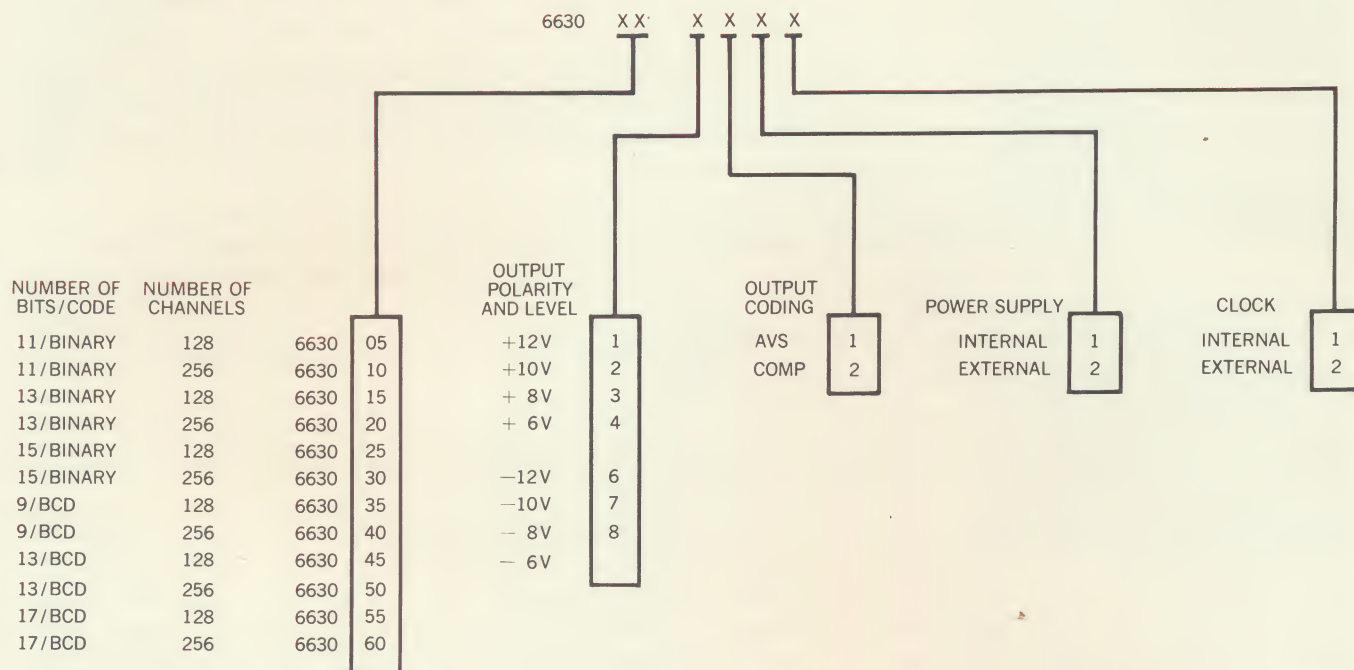
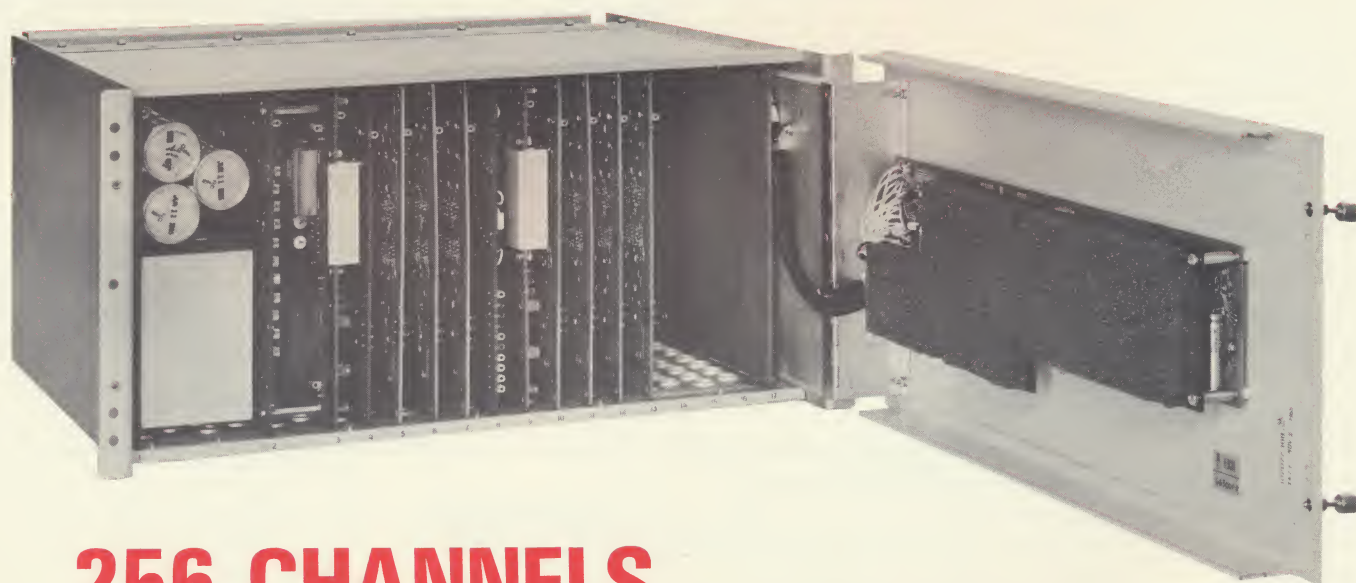
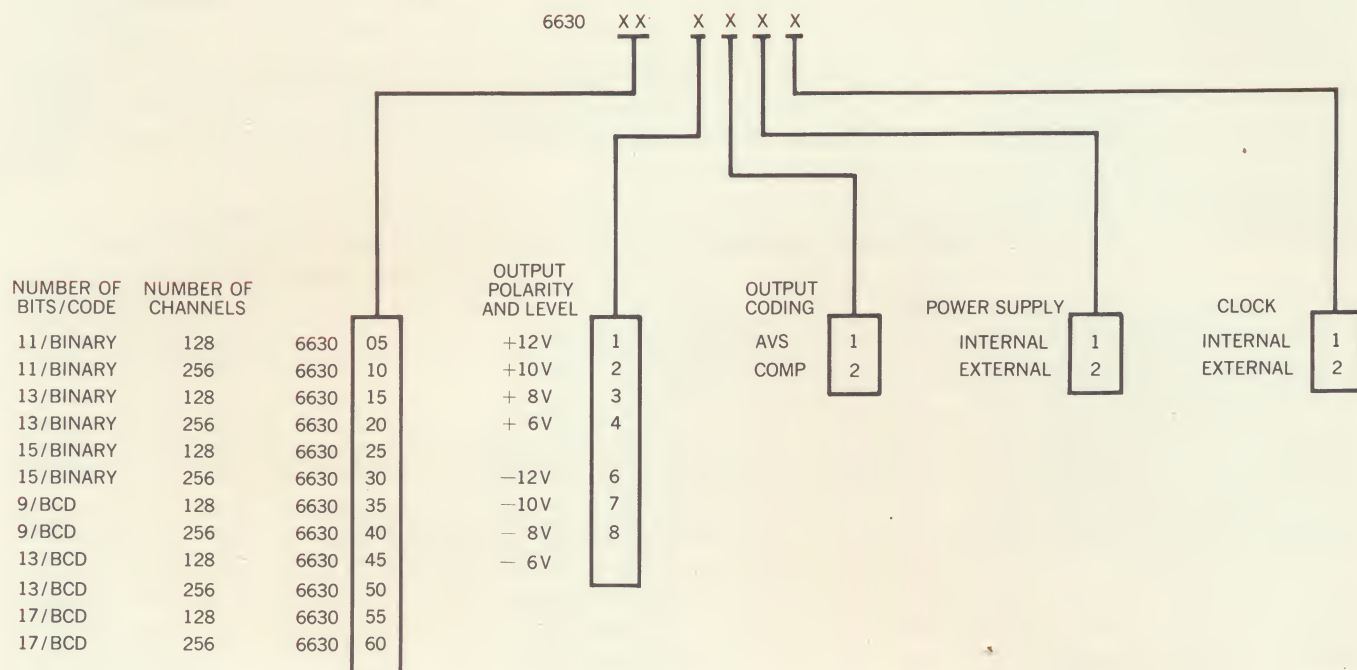


TABLE 1. REDCOR 663 SERIES MODEL IDENTIFICATION NUMBER



32 CHANNELS

TABLE 1. REDCOR 663 SERIES MODEL IDENTIFICATION NUMBER



256 CHANNELS

663 SYSTEM OPERATION

The 663 system can be controlled automatically in the sequential or random access address modes, and by internal or external bit clock. Manual control is provided by front panel multiplexer ADVANCE and DIGITIZE (A-D start) switches. The automatic or manual mode is selected by the AUTO/MANUAL mode select switch on the front panel.

MANUAL MODE — (for maintenance) The system is controlled from the front panel in the manual mode. By use of the ADVANCE switch any desired channel can be selected for monitoring. The conversion process is initiated by the DIGITIZE (A-D start) switch. The digitized result of the selected channel is displayed on the front panel indicators. The manual mode allows self test of the system, monitoring of only one channel, etc.

AUTOMATIC MODE — In this mode of operation the system is completely controlled from an external programmed source. In this manner the system can be operated in the sequential or random access address mode with computer systems.

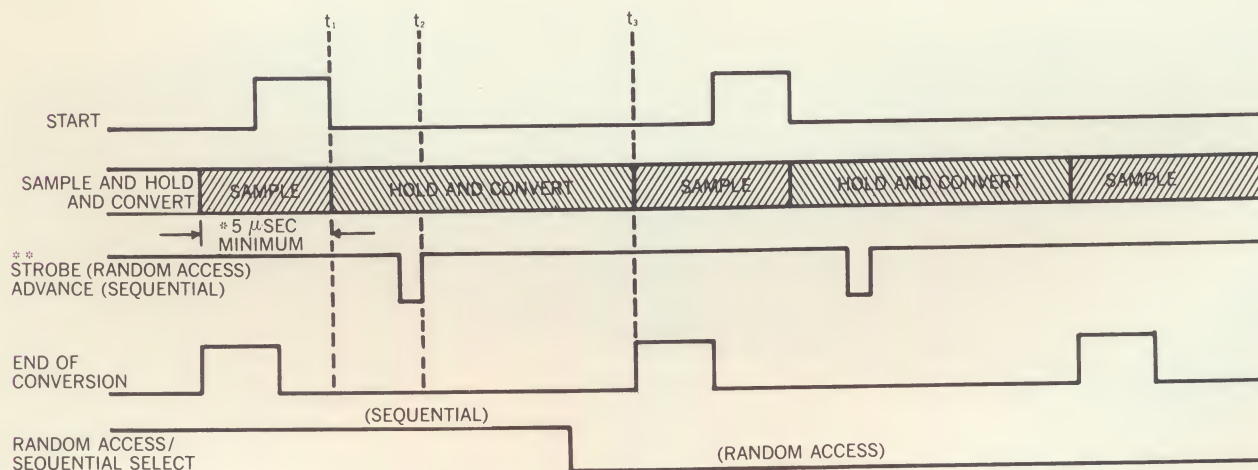
RANDOM ACCESS/SEQUENTIAL ADDRESS CONTROL — The address mode of operation is controlled by a single select line (RANDOM ACCESS/SEQUENTIAL SELECT). Address operation can be changed at any time without affecting the address except during a random access STROBE or sequential ADVANCE pulse. If the address mode is changed during the STROBE or ADVANCE time, the sequential counter could advance by one.

One application of the RANDOM ACCESS/SEQUENTIAL select line is to preset a lower channel during random access, switch to sequential operation, and then advance sequentially from that position. Random access STROBE must occur a minimum of 10 μsec before the next hold and convert (START) input.

Sequential Address — In the sequential address mode of operation, the system is controlled by the start pulse only. When a start pulse is initiated, the system sequentially samples and holds and converts the analog signal. Each channel is then sampled for every successive start pulse and automatically recycles to channel 1 after the last channel selected has been sampled. The last channel is programmable by plug-in patch to provide easy field expansion or reduction of the channels required. The start pulse initiates the cycle. The negative going edge of the start pulse (t_1) initiates the hold and convert mode.

An internally generated select channel pulse (t_2) advances the multiplexer to the next channel to be sampled. At the completion of a cycle, end-of-conversion signal is generated (t_3) and the sample-and-hold amplifier samples the next channel.

Random Access Address — Random access address mode timing is identical to sequential mode timing. In this mode channels to be sampled are randomly selected by an external programmed source. This mode of operation provides many advantages such as monitoring only desired channels, monitoring channels in a selectable sequence, monitoring one channel continuously, etc.



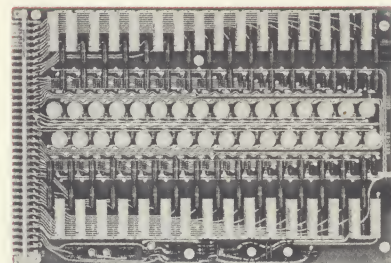
*Controlled by external source and included in throughput rate.

**Random Access strobe must occur 10 μsec (minimum) before the next hold and convert (START) input.

663 SYSTEM DESCRIPTION

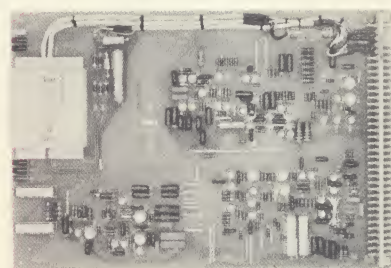
MULTIPLEXER SWITCH

Analog signals are switched by field effect devices which contribute almost zero error and require no potentiometer adjustment. The multiplexer switch and associated circuits are contained in a 12-pin TO-8 cans utilizing hybrid integrated circuit manufacturing techniques. REDCOR's unique multiplexer switches are designed to be plugged into sockets on multiplexer switching modules each capable of accepting up to 32 switches. The 663 Series Data System can accept eight of these modules providing up to 256 channels.



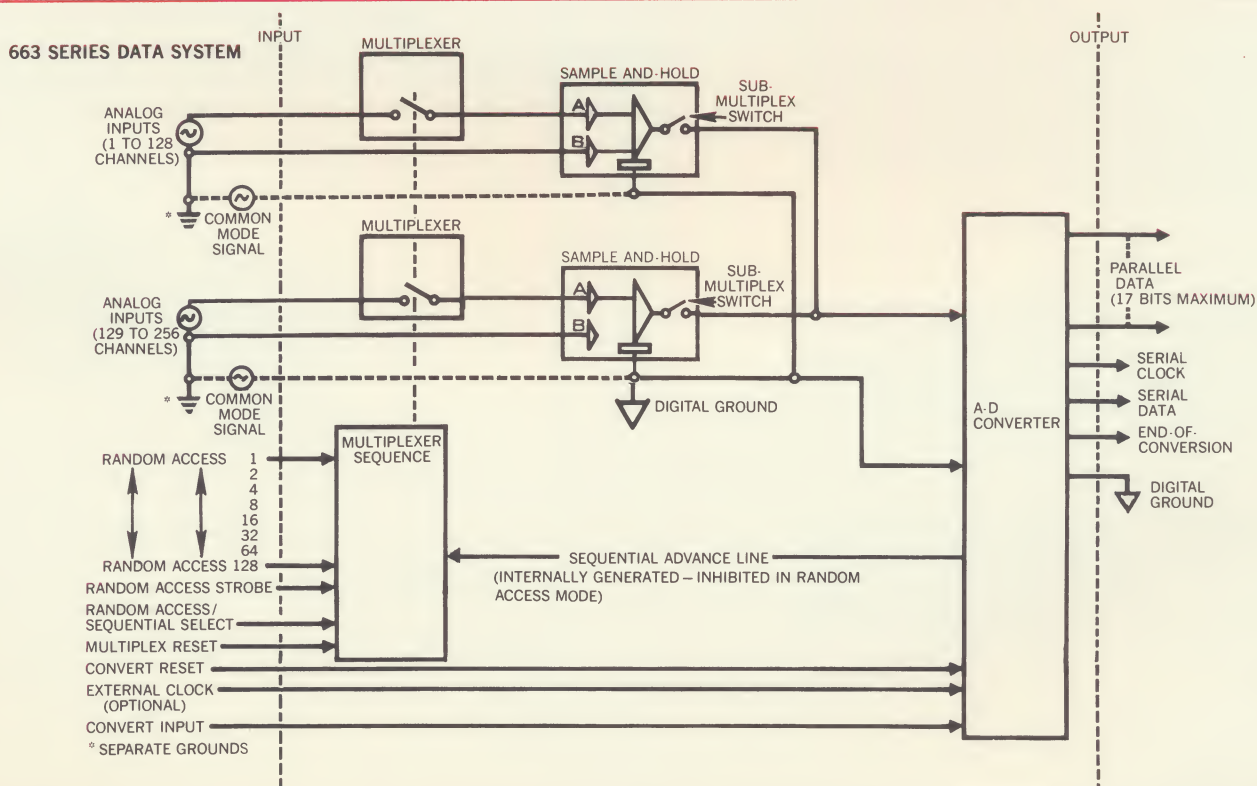
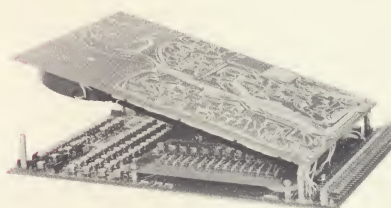
DIFFERENTIAL SAMPLE AND HOLD AMPLIFIER

The Differential Sample and Hold Amplifier Module improves the sampling aperture of the analog-to-digital conversion. In addition, it allows time interlacing of successive multiplexer channels thereby improving total system throughput rate. A unique feature of this sample and hold is its ability to provide isolation between input analog signal grounds and the digital output ground. Typical application therefore would be where a computer ground could be isolated from the analog signal source. This feature allows unprecedented flexibility of systems integration. An additional transistor switch is provided for submultiplexing operations. The 663 System uses one sample and hold module for up to 128 channels and two for up to 256 channels.

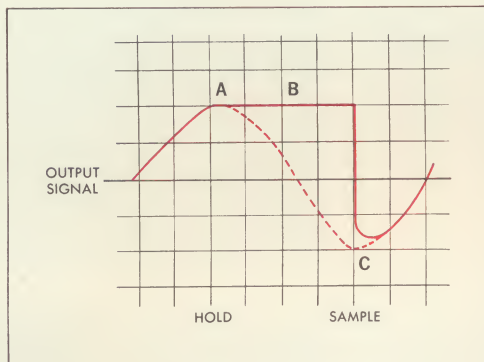


A-D CONVERTER

REDCOR's integrated circuit A-D Converter is bipolar and incorporates clock, reference power supply, comparator, logic and matrix, and output circuitry in a single module. The clock and reference power supply can be slaved to external references. Outputs available are 11, 13, and 15 bit binary or 9, 13, or 17 bit binary coded decimal with true and false digital output levels from 6 to 12 volts dc (both positive and negative).



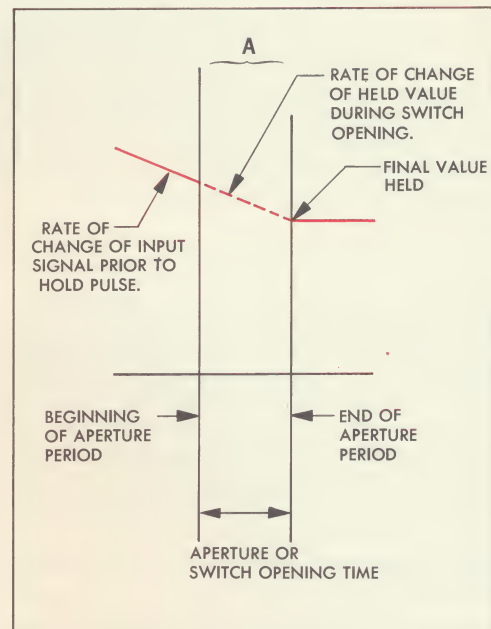
SAMPLE AND HOLD OPERATING WITH SINUSOIDAL INPUT



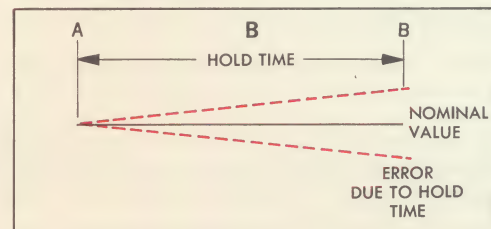
Portion "A" of the waveform is shown expanded into a definite time period called the aperture time. The aperture time is that period required for the sample and hold switch to complete the transition from sample to hold condition.

Portion "B" of the waveform is the voltage at completion of the aperture time. This is the voltage held during the convert period. The expanded graph illustrates the portional error due to hold time of the signal.

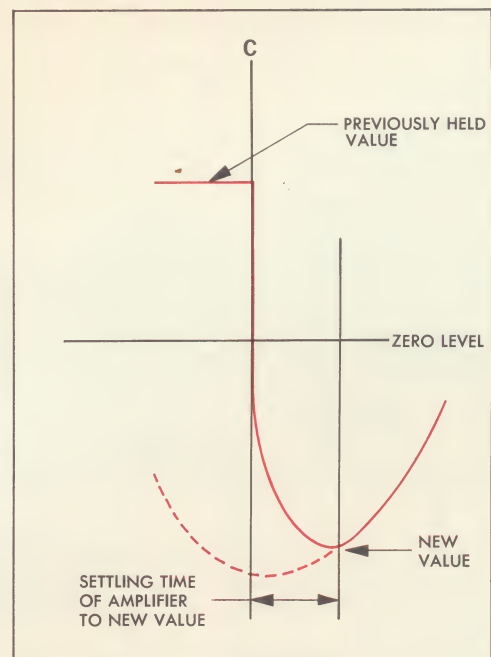
Portion "C" of the curve is shown expanded into the time period required for the sample and hold amplifier to settle to within ± 0.01 percent of the new voltage after switching from the hold to sample condition.



APERTURE TIME



HOLD TIME



SETTLING TIME

SAMPLE AND HOLD APPLICATION

Applications requiring the conversion of a sinusoidal waveform into digital form to an accuracy of ± 0.01 percent requires the use of a sample-and-hold switch. The following discussion illustrates this point.

The sinusoidal waveform is asynchronous such that the hold pulse may occur at any instant within the full period of the waveform.

The maximum rate of change (voltage with respect to time) occurs at the zero axis crossing of the sinusoid. This can be expressed:

$$\text{Maximum rate of change} = W \diamond$$

$$\text{where: } W = 2 \pi f$$

$$\text{and } \diamond = \text{peak amplitude}$$

A given A-D converter requires $t_{\mu\text{secs}}$ for conversion time, therefore, the converter input voltage changes in the following relationship:

$$v = 2 \pi f \diamond t$$

$$\text{where: } v \text{ is the error due to the voltage change during conversion time}$$

Since the conversion time for a given A-D converter is constant, the conversion accuracy is determined by the input frequency. Therefore, any reduction in conversion time will proportionally reduce the error. The conversion time is constant, however, the use of a sample-and-hold switch with an aperture time of t_1 will reduce the error since the aperture time is theoretically the conversion time. Therefore:

$$v_1 = 2 \pi f \diamond t_1$$

$$\text{or } \frac{v_1}{v} = \frac{t_1}{t}$$

$$\text{where: } \diamond \text{ and } f \text{ are constant}$$

However, if v is to be considered a constant allowable error the sample-and-hold switch will allow a maximum frequency to be sampled. This frequency can be calculated:

$$\left(\frac{t}{t_1} \right) \left(\begin{array}{l} \text{A-D conversion frequency} \\ \text{without sample and hold switch} \end{array} \right)$$

Example:

The amount of signal change that can be detected within 22.5 μsec by a 15-bit binary A-D is $\pm 0.005\%$. This requires that the input be held this constant during the sampling period. Therefore, the improvement gained by a 0.1 μsec sample and hold is

$$\frac{22.5}{0.1} = 225:1$$

COMPLETE SYSTEMS COMPATIBILITY

 **REDCOR**
C O R P O R A T I O N

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